

What is claimed is:

1. A speech signal decoding method comprising the steps of:  
2. decoding information containing at least a sound source signal, a gain, and filter coefficients from a received bit stream;  
3. identifying voiced speech and unvoiced speech of a speech signal using the decoded information;  
4. performing smoothing processing based on the decoded information for at least either one of the decoded gain and the decoded filter coefficients in the unvoiced speech; and  
5. decoding the speech signal by driving a filter having the decoded filter coefficients by an excitation signal obtained by multiplying the decoded sound source signal by the decoded gain using a result of the smoothing processing.

2. A method according to claim 1, wherein the method further comprises the step of classifying unvoiced speech in accordance with the decoded information, and the step of performing smoothing processing comprises the step of performing smoothing processing in accordance with a classification result of the unvoiced speech for at least either one of the decoded gain and

9 the decoded filter coefficients in the unvoiced speech.

3. A method according to claim 1, wherein the  
2 identifying step comprises the step of performing  
3 identification operation using a value obtained by  
4 averaging for a long term a variation amount based on a  
5 difference between the decoded filter coefficients and  
6 their long-term average.

4. A method according to claim 2, wherein the  
2 classifying step comprises the step of performing  
3 classification operation using a value obtained by  
4 averaging for a long term a variation amount based on a  
5 difference between the decoded filter coefficients and  
6 their long-term average.

5. A method according to claim 1, wherein  
2 the decoding step comprises the step of  
3 decoding information containing pitch periodicity and a  
4 power of the speech signal from the received bit stream,  
5 and  
6 the identifying step comprises the step of  
7 performing identification operation using at least  
8 either one of the decoded pitch periodicity and the  
9 decoded power.

6. A method according to claim 2, wherein

2                   the decoding step comprises the step of  
3   decoding information containing pitch periodicity and a  
4   power of the speech signal from the received bit stream,  
5   and

6                   the classifying step comprises the step of  
7   performing classification operation using at least  
8   either one of the decoded pitch periodicity and the  
9   decoded power.

7.                 A method according to claim 1, wherein  
2                   the method further comprises the step of  
3   estimating pitch periodicity and a power of the speech  
4   signal from the excitation signal and the decoded speech  
5   signal, and

6                   the identifying step comprises the step of  
7   performing identification operation using at least  
8   either one of the estimated pitch periodicity  
9   information and the estimated power.

8.                 A method according to claim 2, wherein  
2                   the method further comprises the step of  
3   estimating pitch periodicity and a power of the speech  
4   signal from the excitation signal and the decoded speech  
5   signal, and

6                   the classifying step comprises the step of  
7   performing classification operation using at least  
8   either one of the estimated pitch periodicity and the

9 estimated power.

9. A method according to claim 2, wherein the  
2 classifying step comprises the step of classifying  
3 unvoiced speech by comparing a value obtained by the  
4 decoded filter coefficients with a predetermined  
5 threshold.

*SHY* 10. A speech signal decoding apparatus

2 comprising:

3 a plurality of decoding means for decoding  
4 information containing at least a sound source signal, a  
5 gain, and filter coefficients from a received bit  
6 stream;

7 identification means for identifying voiced  
8 speech and unvoiced speech of a speech signal using the  
9 decoded information;

10 smoothing means for performing smoothing  
11 processing based on the decoded information for at least  
12 either one of the decoded gain and the decoded filter  
13 coefficients in the unvoiced speech identified by said  
14 identification means; and

15 filter means which has the decoded filter  
16 coefficients and is driven by an excitation signal  
17 obtained by multiplying the decoded sound source signal  
18 by the decoded gain, at least either one of the decoded  
19 filter coefficients and the decoded gain using an output

*SK* 20 result of said smoothing means.

11. An apparatus according to claim 10, wherein  
2       said apparatus further comprises  
3 classification means for classifying unvoiced speech in  
4 accordance with the decoded information, and  
5        said smoothing means performs smoothing  
6 processing in accordance with a classification result of  
7 said classification means for at least either one of the  
8 decoded gain and the decoded filter coefficients in the  
9 unvoiced speech identified by said identification means.

12. An apparatus according to claim 10, wherein  
2 said identification means performs identification  
3 operation using a value obtained by averaging for a long  
4 term a variation amount based on a difference between  
5 the decoded filter coefficients and their long-term  
6 average.

13. An apparatus according to claim 11, wherein  
2 said classification means performs classification  
3 operation using a value obtained by averaging for a long  
4 term a variation amount based on a difference between  
5 the decoded filter coefficients and their long-term  
6 average.

14. An apparatus according to claim 10, wherein

2               said decoding means decodes information  
3 containing pitch periodicity and a power of the speech  
4 signal from the received bit stream, and  
5               said identification means performs  
6 identification operation using at least either one of  
7 the decoded pitch periodicity and the decoded power  
8 output from said decoding means.

15.           An apparatus according to claim 11, wherein  
2               said decoding means decodes information  
3 containing pitch periodicity and a power of the speech  
4 signal from the received bit stream, and  
5               said classification means performs  
6 classification operation using at least either one of  
7 the decoded pitch periodicity and the decoded power  
8 output from said decoding means.

16.           An apparatus according to claim 10, wherein  
2               said apparatus further comprises estimation  
3 means for estimating pitch periodicity and a power of  
4 the speech signal from the excitation signal and the  
5 decoded speech signal, and  
6               said identification means performs  
7 identification operation using at least either one of  
8 the estimated pitch periodicity and the estimated power  
9 output from said estimation means.

17. An apparatus according to claim 11, wherein  
2           said apparatus further comprises estimation  
3 means for estimating pitch periodicity and a power of  
4 the speech signal from the excitation signal and the  
5 decoded speech signal, and  
6           said classification means performs  
7 classification operation using at least either one of  
8 the estimated pitch periodicity and the estimated power  
9 output from said estimation means.

18. An apparatus according to claim 11, wherein  
2 said classification means classifies unvoiced speech by  
3 comparing a value obtained by the decoded filter  
4 coefficients from said decoding means with a  
5 predetermined threshold.

19. A speech signal decoding/encoding method  
comprising the steps of:  
3           encoding a speech signal by expressing the  
4 speech signal by at least a sound source signal, a gain,  
5 and filter coefficients;  
6           decoding information containing a sound source  
7 signal, a gain, and filter coefficients from a received  
8 bit stream;  
9           identifying voiced speech and unvoiced speech  
10 of the speech signal using the decoded information;  
11          performing smoothing processing based on the

12 decoded information for at least either one of the  
13 decoded gain and the decoded filter coefficients in the  
14 unvoiced speech; and  
15 decoding the speech signal by driving a filter  
16 having the decoded filter coefficients by an excitation  
17 signal obtained by multiplying the decoded sound source  
18 signal by the decoded gain using a result of the  
19 smoothing processing.

20. A speech signal decoding/encoding apparatus  
2 comprising:

3 speech signal encoding means for encoding a  
4 speech signal by expressing the speech signal by at  
5 least a sound source signal, a gain, and filter  
6 coefficients;

7 a plurality of decoding means for decoding  
8 information containing a sound source signal, a gain,  
9 and filter coefficients from a received bit stream  
10 output from said speech signal encoding means;

11 identification means for identifying voiced  
12 speech and unvoiced speech of the speech signal using  
13 the decoded information;

14 smoothing means for performing smoothing  
15 processing based on the decoded information for at least  
16 either one of the decoded gain and the decoded filter  
17 coefficients in the unvoiced speech identified by said  
18 identification means; and

19               filter means which has the decoded filter  
20   coefficients and is driven by an excitation signal  
21   obtained by multiplying the decoded sound source signal  
22   by the decoded gain, at least either one of the decoded  
23   filter coefficients and the decoded gain using an output  
24   result of said smoothing means.